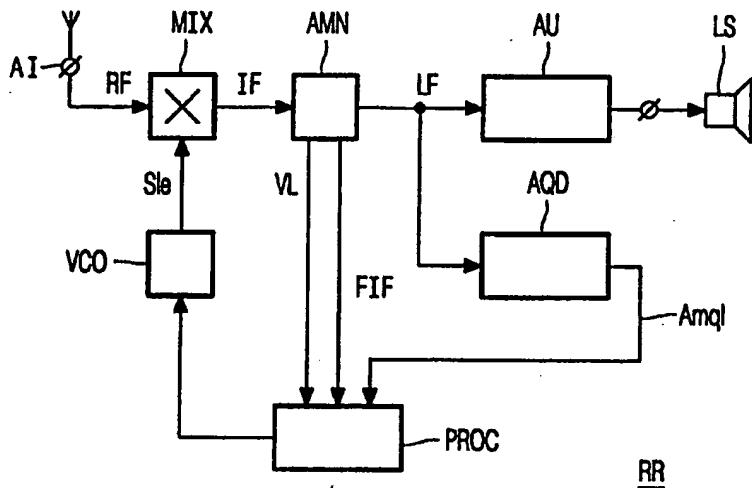




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(54) Title: AM QUALITY DETECTOR



(57) Abstract

During an automatic scanning of an AM frequency band it is required that the scanning is only stopped when a usable audio signal is received. To achieve this normally the receiver checks the (RF) signal level and the IF frequency of the received signal. Because at night the propagation of AM signals is improved as a consequence of the weather conditions it is possible that a far away station having the same transmitting frequency interferes with a local station. To overcome this a detector and receiver are proposed whereby the detector detects interferences of two or more stations and supplies a detection signal resulting in resuming scanning for a next station.

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AM quality detector.

The invention relates to a receiver as described in the preamble of claim 1.

The invention further relates to a detector for use in such a receiver.

The invention further relates to a method of scanning a frequency band as described in the preamble of claim 5.

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Such a receiver and method are known and used in the art.

Further receivers are known having means to overcome the problem of interference of adjacent channels/stations. For example the international patent application WO 97/23959 describes such a receiver.

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During automatic scanning an AM frequency band the receiver checks the (RF) signal level and the IF frequency of the received signal. On the basis hereof it is decided if a usable AM signal is received or not. If yes this signal is further processed and supplied to the loudspeaker(s) of the receiver. If not the frequency is changed with a predetermined value and the same checks are repeated for this new signal.

Transmitter frequencies of AM stations are normally chosen in such a way that they cause each other minimal interference's. This however is only valid during day time. At night the ionisation of the ionosphere changes dramatically and temperature inversions occur, causing a significant improvement of propagation. This in turn results in strong reception of far away stations that can not be received during day time. Because these distant stations cannot be received under normal conditions, they can use the same transmitter frequency as nearby transmitters. This is no problem during day time but at night such a distant station can cause major interference's with a local station. The frequencies of these interference's are called beat frequencies. These interference's can reach a level that make the station unusable, in that case such a station should be skipped during auto search.

A disadvantage of the known receiver is that after checking the signal level and the IF frequency and it is decided that they are usable, the signal is further processed and

supplied to the loudspeaker(s). Whereas the interference's that are not detected can cause the supplied signal to be not suitable for reproducing the audio signal.

5 An object of the invention is to provide a receiver, and a detector that have not the disadvantages of the prior art and further to improve the performance of the receiver. To this end a first aspect of the invention provides a receiver as claimed in claim 1. A second aspect of the invention provides a detector as claimed in claim 4. A third aspect of the invention provides a method of scanning a frequency band as claimed in claim 5.

10 During an (automatic) search for available AM radio stations it is preferred that the receiver only stops searching when a usable station has been found. That is having a usable RF frequency, a signal level above a predetermined value and no interference's with another station, for example a far away station (especially at night). This is achieved with the receiver according to the invention by using a detector which detects whether or not two (or more) 15 signals are received having (nearly) the same transmitter frequency. When the detector detects an interference the detector supplies a detection signal to the processor to resume scanning for a next station.

Because at the moment the AM stations in the US are all privately owned, they use crystal-stabilised transmitters (compared to the state owned European stations (at the 20 moment) who use an atomic clock for reference). The result of this is that the simultaneous reception of two US AM stations (with the same transmitting frequency) produces a beat frequency in a receiver of about 0 to 40 Hz with an amplitude of about double of normal modulation. It is this beat frequency that can be used advantageous to acquire the amount of multiple reception by the detector.

25 Especially under US conditions (or in other countries with similar transmitter conditions) this system provides a great improvement in AM automatic search during the evening hours.

Because the AM quality is checked after the signal level and IF frequency have been checked, there is no reduction of search speed.

30 The detector can easily be added to an existing AM receiver, with minimal cost.

It is to be noticed that from the European patent application EP-A-0410663 a receiver is known for receiving an amplitude modulated signal with upper and lower sidebands. The receiver further comprises a quality detector to provide upper and lower

quality signals representative of undesired noise in the demodulated upper and lower sideband audio signals and a selector responsive to the quality signals for processing upper and lower sideband audio signals to provide an audio output signal with reduced noise.

5 An embodiment of a receiver according to the invention comprises the features of claim 2.

A beat frequency of about 0 to 40 Hz can be detected using a low-pass filter with a 40 Hz cut-off frequency, followed by an amplifier/rectifier producing a DC voltage proportional to the amount of interference, as a detection signal.

10

An embodiment of a method according to the invention comprises the features of claim 6.

To prevent that the detector is triggered on one single erroneous pulse the operation of the method is further improved by measuring more than once with an 15 predetermined interval there between.

The invention and additional features which may optionally be used to implement the invention to advantage will be apparent from and elucidated with reference to the examples described hereinafter and shown in the figures. Herein shows :

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Figure 1 a block schematic example of a receiver according to the invention, and

Figure 2 a block schematic example of an AM quality detector according to the invention.

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Figure 1 shows a block schematic example of a radio receiver RR according to the invention, having an antenna input AI for receiving a RF signal. A mixer unit MIX for mixing the RF signal with a local oscillator signal Slo from an oscillator unit VCO, and supplying an IF signal. This IF signal is supplied to an AM unit for amplifying the IF signal and detecting an AM signal and supplying an (unfiltered) AM signal LF. The AM unit supplies a signal level V1 and a frequency signal FIF to a processor unit PROC, which processor unit supplies a signal to the oscillator VCO. When the signal level V1 and/or the IF signal is/are not within the predetermined range the processor unit PROC will supply a (new) voltage signal to the oscillator unit to amend the local oscillator signal, for example during an

automatic search. An output of the AM unit is coupled to an audio unit AU for further processing the unfiltered AM signal LF, and supplying the processed signal to a loudspeaker LS.

The processor unit further comprises means for automatic scanning (searching) 5 a frequency band. In this example this can be achieved by supplying each time a higher (or lower) voltage to the oscillator unit (here implemented as a so called voltage controlled oscillator).

The radio receiver RR according to the invention further comprises an AM quality detector AQD (see figure 2 for a detailed description) for detecting whether or not a 10 usable AM signal is received. So performing an interference check. The AM quality detector receives the unfiltered AM signal LF. This is necessary because otherwise the interference's would have been filtered out (for example after the audio unit (AU)).

During an (automatic) search for available AM radio stations it is preferred that the receiver only stops searching when a usable station has been found. That is having an 15 usable RF frequency, a good signal level and no interference's with a far away station (especially at night). This is achieved with the receiver according to the invention by using the AM quality detector which detects whether or not two (or more) signals from stations are received having (nearly) the same transmitter frequency. When the AM quality detector detects an interference the AM quality detector supplies a detection signal AMql to the 20 processor unit PROC to resume scanning for a next station.

Because at the moment the AM stations in the US are all privately owned, they use crystal-stabilised transmitters (compared to the (at the moment) state owned European stations who use an atomic clock for reference). The result of this is that the reception of two 25 US AM stations (with the same transmitting frequency) simultaneously produces a beat frequency in a receiver of about 0 to 40 Hz with an amplitude of about double of normal modulation. It is this beat frequency that can be used advantageous to acquire the amount of multiple reception by the detector.

30 Figure 2 shows an example of an AM quality detector AQD2 in more detail. The AM quality detector receives at an input the unfiltered AM signal LF2, which signal is supplied to a low pass filter LPF2, for example with a cut-off frequency of 40 Hz for obtaining only the signal components (that is interference's) below 40 Hz. By filtering out signals above about 40 Hz it is prevented that the AM quality detector can react on (real) low frequency AM

audio signals. This signal is amplified in an amplifier AMP2. The output of the amplifier is coupled with detecting means DET2, for example creating a DC level, and for detecting the value of the signal below 40 Hz, and supplying a detecting signal AMql2 to the processor unit(PROC, see figure 1), which processor unit will decide on the basis of the value of the detection signal AMql2 whether or not a usable AM signal is received or not.

The cut-off frequency of about 40 Hz is chosen to prevent the AM quality detector from measuring normal audio signals. A four pole filter is preferred because a fast decrease is needed to prevent the AM quality detector from detecting low frequency audio signals.

To improve the operation of the AM quality detector and the receiver further the measuring of the detection signal is performed more than once with a predetermined interval, for example three times with intervals of 20 ms.

It is preferred that the AM quality detector sensitivity decreases if the signals of the two transmitters have a difference in signal strength. The greater the difference in received antenna signal is, the more the sensitivity of the AM quality detector can be reduced. This is desirable because when two stations are received on nearly the same transmitter frequency with a great difference in signal strength, the strongest will prevail over the weaker one. So the strongest station will produce audio with minimal audio distortion by the weaker station. Therefore preferably such a station shouldn't be skipped during auto search.

Further when the receiver tunes onto a station it is possible that the AM quality detector supplies a detection signal as a consequence of the tuning step. The detection signal will be proportional to the signal level of the received signal. As a consequence the AM quality detector would erroneously indicate that a disturbed, not usable signal, is received and that scanning for a (following) station should be resumed.

To overcome this it is possible to obtain a hardware solution, however this requires a link between the so called front-end and the so called IF/AM detector (AM unit). This link is not desirable due to the risk of cross interference's between different elements of the receiver, resulting in whistles, instabilities or worse.

So it is preferred to obtain a software solution, using a software algorithm.

When a station is found during an automatic search first the signal level (VI) is checked and if the level is found to be above a predetermined value, the IF frequency (FIF) is checked. When the IF frequency is also found to be within the required IF window, the AM quality (AMql) is measured. Because the signal level of the tuned station is known at that point, it is possible to make a delay proportional to this level. Following this delay for example three measurements

are performed with for example 20 ms interval. The average of this measurement should not be equal or higher than a given level. Due to this proportional delay the unwanted pulse (due to the received station tuned to) has enough time to decrease before the AM quality measurement (interference check) is performed. A short delay for small antenna signals and 5 the delay is made longer as the antenna signal increases. The delay can be chosen using measurements of the shape of the unwanted pulse at various antenna inputs.

Because the AM quality is read after the signal level and the IF frequency have been checked, there is no reduction of search speed.

Further when the signal level of one of the two signals is considerable less than 10 the signal level of the other, the sensitivity of operation of the AM quality detector (interference check) is decreased, because the received signal with the strongest signal level will dominate.

In the above description the idea of the invention has been described on the basis of an detail example. The man skilled in the art will be well aware of a lot of different 15 solutions that fall within the scope of the invention concerned.

The various blocks in the figures can be implemented with discrete or integrated circuits, but can also be implemented digitally for example in a digital signal processor (for example the processing unit PROC in figure 1).

20 The invention provides a receiver, a detector and a method using an AM quality detector to overcome the problem of stopping automatic scanning (searching) at unuseful (radio) stations, especially at night.

After deciding that the AM signal level is above a minimum level, and the IF frequency is within a predetermined frequency window, the AM quality detector detects 25 whether interference is present. This interference results in a detection signal in the lower frequency range (for example 0 to 40 Hz) which detection signal is used by the processing unit to resume searching for a next station.

## Claims:

1. Receiver comprising a mixer unit for receiving a RF signal, an oscillator unit coupled to the mixer unit, an AM unit for receiving an IF signal from the mixer unit and for amplifying and detecting an AM signal, an audio unit for processing the AM signal and supplying an output signal to a loudspeaker, and a processing unit coupled to the AM unit and the oscillator unit for controlling the oscillator unit, which processing unit further comprises means for automatic scanning a frequency band,  
characterised in that the receiver comprises a detector coupled to an output of the AM unit for detecting interference between at least two received input signals having nearly the same frequency, and for supplying a detection signal to the processing unit.  
10
2. Receiver as claimed in claim 1, characterised in that the detector comprises a low pass filter for filtering out the AM signal.
3. Receiver as claimed in claim 2, characterised in that the detector comprises rectifying means for rectifying the filtered signal and supplying the detection signal.  
15
4. Detector for use in a receiver according to claim 1.
5. Method for scanning an AM frequency band in a receiver, having the steps of changing the frequency each time with a predetermined value, detecting whether or not a signal is received, comprising checking a signal level, checking an IF frequency, and deciding on stop scanning or resume scanning, characterised in that after checking the signal level and the IF frequency, an interference check is performed comprising low pass filtering of an unfiltered AM signal and obtaining a detection signal and deciding to whether or not stop scanning for a station.  
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25
6. Method as claimed in claim 5, characterised in that depending on the received signal value, a delay is determined, where after the interference check is performed and deciding whether or not stop scanning.

7. Method as claimed in claim 5 characterised in that the interference check is performed a number of times with predetermined intervals there between.
  
8. Method as claimed in claim 5, characterised in that depending on the difference 5 in signal value of the simultaneously received signals the sensitivity of the interference check decreases.

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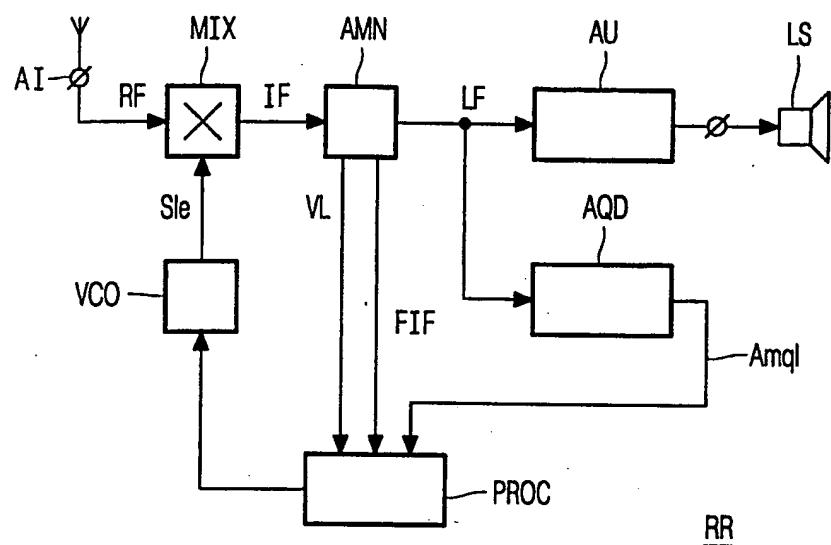


FIG. 1

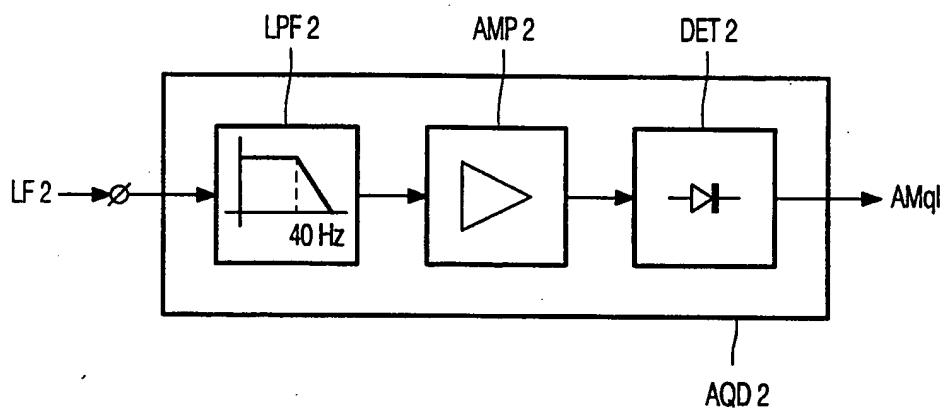


FIG. 2